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Fort Collins, Colorado

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Erosion
Surveys

September 10, 1936.

EROSION CONTROL ON THE BEARLODGE FIRE AREA



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"History repeats itself" - the streams from a freshly burned area have again overflowed their normal channels with flood waters carrying more or less soil, rock and other debris. In this instance the age-old sequence of events - fire - rain - rapid runoff - erosion - has been revived on the Bearlodge fire area in northeastern Wyoming and this report covers an inspection of the area made to determine the necessity and feasibility of instituting erosion control measures thereon.

The Fire

On July 7, 1936, a fire was reported near the town of Sundance, Wyoming. It was a day of high winds, low humidity and fuels were tinder dry following prolonged and unprecedented drought. Immediate action was taken by the Forest Service to control the fire but in a matter of minutes it became a conflagration and ultimately reached an area of approximately 7500 acres. The point of origin of the fire was on privately owned land but before it had burned more than one-half mile it had reached the national forest boundary and eventually burned over approximately 6700 acres within the Bearlodge division, Black Hills National Forest.

Needless to say, under the hazardous conditions previously described the fire burned with extreme intensity. Most of first day and night the fire ran through the crowns of the trees and it is estimated that on approximately 40 percent of the burned area all of the timber has been killed by crown fires. On the remaining 60 percent of the area the fire burned with varying degrees of intensity ranging from a light surface fire which burned only a portion of the lesser vegetation to a severe surface fire which consumed the lesser vegetation and killed the overstory of trees without igniting the foliage. The most severely burned portions of the area are those in Trent, South Ogden, Main Ogden and other minor canyons near the point of origin of the fire.

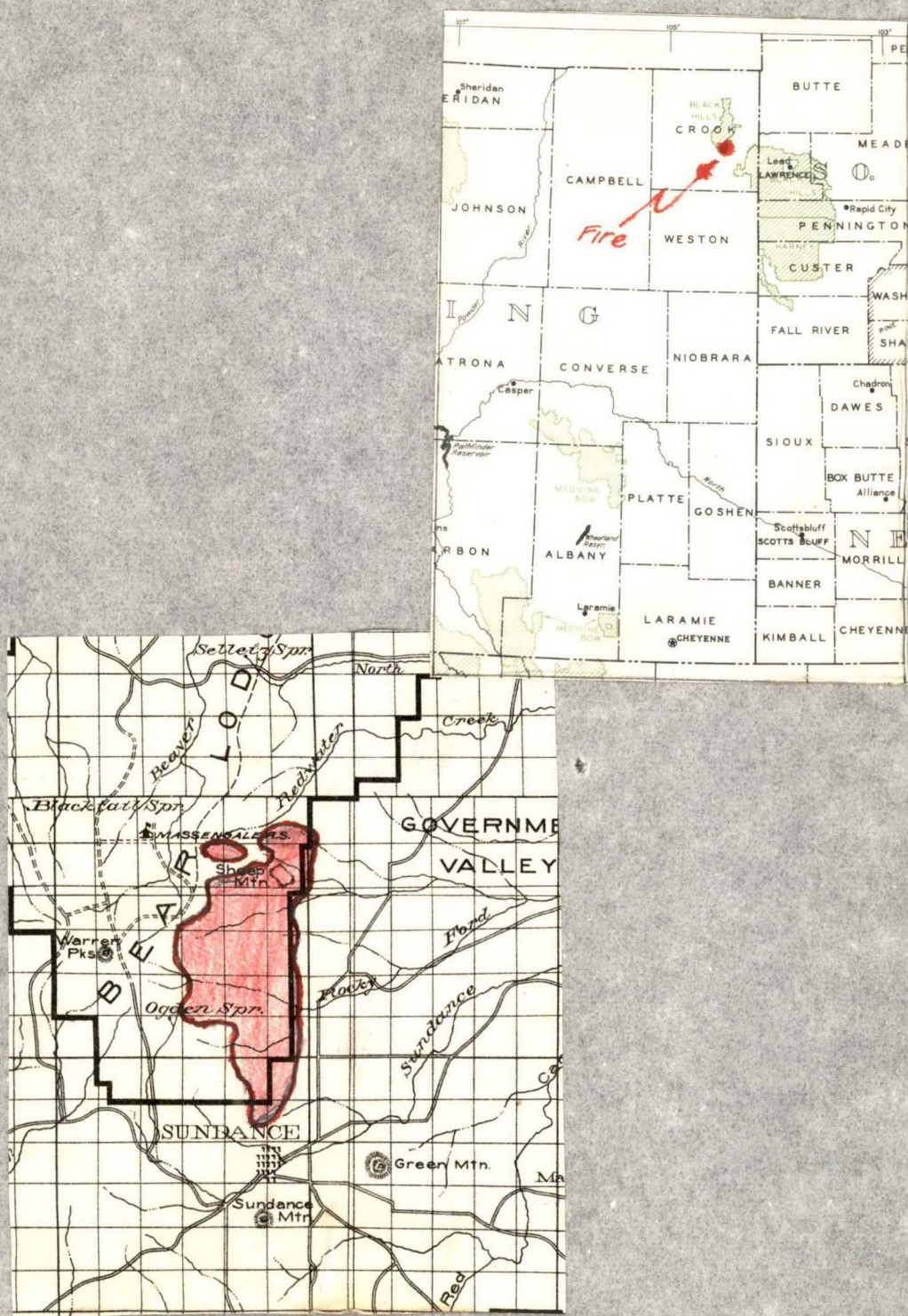


Fig. 1. Location of Bearlodge fire in reference to village of Sundance and small overlay showing location of the fire in reference to national forests and other points in Wyoming and South Dakota.

Over the fire as a whole it is further estimated that approximately 70 percent of the merchantable volume of the timber stand was killed and that stocking of the area by forest trees was reduced in the neighborhood of 85 percent. In general it may be said that the fire was typical of any burn occurring under extremely hazardous conditions on steep, broken terrain supporting a stand of ponderosa pine timber.

Factors Influencing Erosion

Broadly speaking it can be said that erosion occurring or likely to occur on any area is influenced mainly by the topography, soil, climate and vegetation. For the sake of simplicity and brevity, therefore, these four factors will be discussed independently for the Sundance fire area.

Topography

Steep and "broken" topography acts in many ways to influence erosion. Obviously, the steeper the slope the easier soil can be removed and the steeper the gradient of streams the more silt and debris can be transported. Ordinarily the reverse holds true in regard to what is commonly termed "broken topography". The more "broken" the topography the more rock cliffs. These cliffs serve to gain elevation very rapidly and little soil is exposed to the force of erosion except on rather gentle slopes on plateaus or benches above and below the cliffs. In regard to streams in a region of "broken" topography, ordinarily they do not have long, steep gradient channels, instead they pass for a short distance over precipitous falls and then remain on a rather gentle gradient until the next precipitous drop is reached and so on in a series of steps, each tread of the step allowing the velocity of the stream to slacken and its load to be deposited.

On the Bearlodge fire area the topography is combination of steep slopes with rather steep gradient streams and rock cliffs and "stair step" streams. Fortunately, the latter is found on the most severely burned portion of the area and examination shows that the streams flow normally on more or less rock lined channels in their steepest portions thus making it impossible for high peak flow as a result of denudation to accelerate the erosion of the channel and accumulate a silt load from this source. Furthermore on these "stair step" streams evidences of age-old deposits can be found in the low gradient portions of the channel. These deposits are now stabilized



Fig. 2. Trent Canyon. Fire extremely severe in this canyon yet comparatively little accelerated erosion is possible because of shallow, rocky soil and the nature of the topography formed by the rock cliffs.



Fig. 3. Typical rock channel in which very little erosion can take place.

and undoubtedly most of the material which may reach the streams from the slopes except that which is in suspension will be deposited in natural catchment basins before the streams ever leave the fire area. Therefore, while the topography is not ideal from the standpoint of the prevention of erosion, it is so combined with the manner in which the fire burned and the valley lands below that scarcely a better set of circumstances from the standpoint of lack of destructive soil movement could be found on any mountain fire area.

Soil

Soil as a factor influencing erosion on any given area is extremely important. On the Sundance area it so happens that soil conditions tend to reduce the erosion potential to a point where in the opinion of the investigators great mud-rock flows and serious erosion is unlikely. To be sure some soil will be removed from the slopes and channels along with the flood flows which are almost sure to occur until the area has been revegetated but by no means can the situation compare with other areas elsewhere in the west from the standpoint of susceptibility to erosion.

In the first place the soil, largely of limestone origin, is very shallow over a large part of the area and in many places there is none whatsoever - only barren rock since the litter has been consumed by the fire. Incidentally, only a small part of the most badly burned area has soil enough to permit use of terraces as an erosion control measure. Shallow soil and great areas of rock outcrops naturally means a minimum of material to erode. Secondly, what soil there is on the slopes is extremely rocky and in the places most susceptible to erosion a natural pavement of rock fragments exists. Both of these factors tend to reduce the possibility of serious erosion to a minimum.

In some dry ravines where soil has been deposited in past geological ages and has been held in place by sod there is an ever present threat of erosion should the roots be destroyed. Areas such as these were examined very closely and while drought and fire have combined to give the appearance that the grass sod is dead, a close inspection of the roots indicated that abundant life still exists. None the less these bottoms should be watched and if revival of vegetation is not immediate following a break in the drought, artificial seeding is recommended. Along live streams no particular fear of excessive erosion is felt in that the channels are still lined with living grass, shrubs and trees. Therefore, from the soil

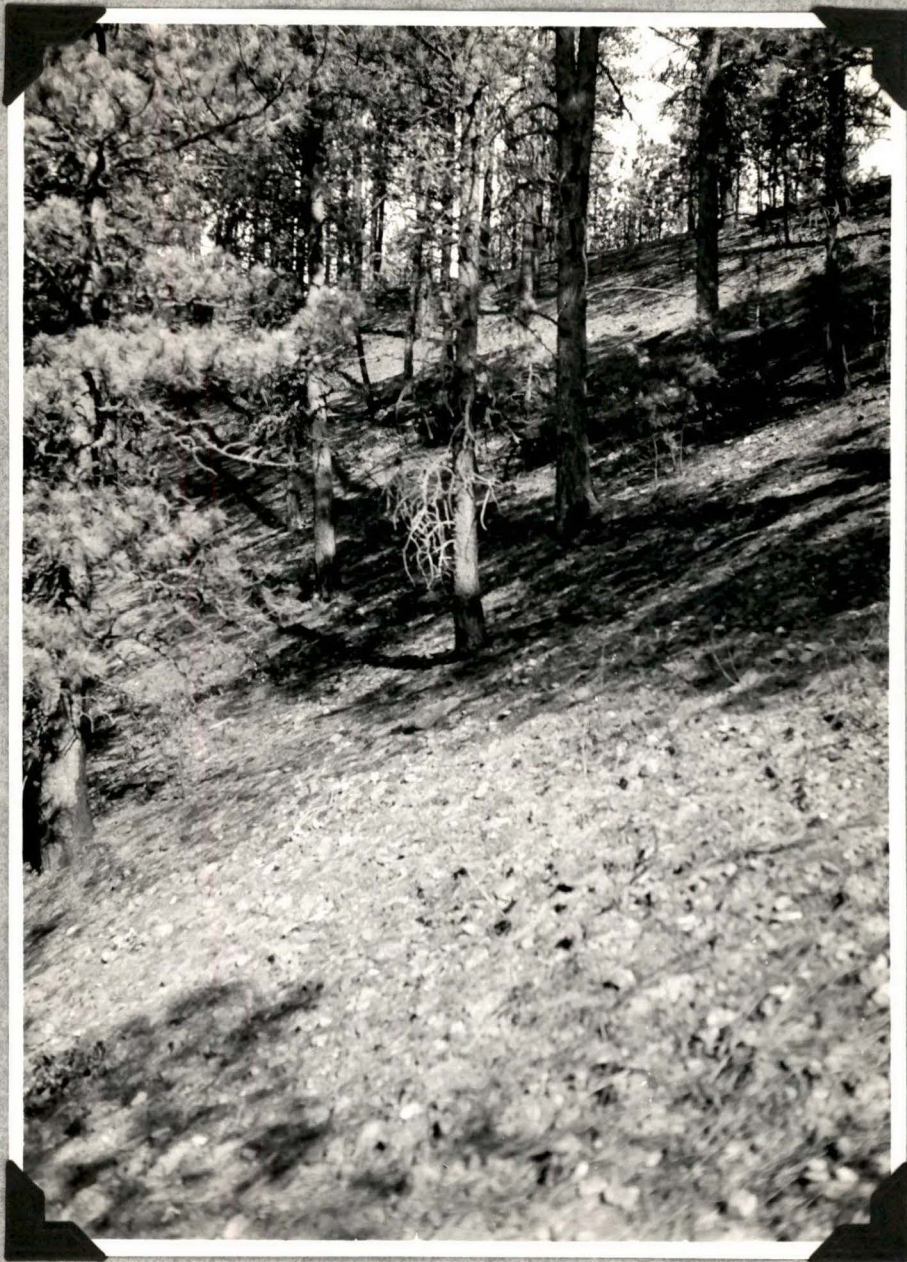


Fig. 4. Steep slope in Cole Canyon. Note rock fragments covering the surface and lack of evidence of gully formation.



Fig. 5. Trent Canyon. Rocky outcrops in both foreground and background illustrate shallowness of soil. Note that in channel where man is standing there has been no erosion in spite of the rapid run-off which must have come from the exposed rock surfaces.

standpoint as with topography it appears that nature has been kind to those responsible for erosion control work in this locality.

Climate

Climate as it influences erosion is confined in this case almost exclusively to the precipitation factor -- wind, the other great eroding force, is of little importance. In contrast to the topography and soil the character of the precipitation in Sundance region makes for more or less rapid erosion. This is true for the following reasons: (1) the greatest precipitation occurs during the summer months meaning that the moisture falls as rain which tends to produce much more runoff and erosion than an equal quantity falling as snow during the winter season, and (2) according to local residents the storms are of comparatively high intensity such as characterize a cloudburst zone. In the most recent storm, for instance, which resulted in high water and some soil removal from the fire area, 1.02 inches fell in Sundance in from 20 to 30 minutes as determined by a local cooperative observer of the U. S. Weather Bureau. It should not be construed from this statement, however, that the very intense storms of considerable duration such as occur in other parts of the west also occur at Sundance because in the seven years, 1929 to 1935, inclusive, only 30 storms have exceeded .50 inches of rainfall in 24 hours, only eight of these storms exceeded 1.00 inches and only two of them exceeded 2.00 inches in 24 hours, the greatest being 2.23 inches. Rainfall, therefore, while of a type to cause considerable damage should not be considered as being an unsurmountable threat toward rehabilitation of the area before complete devastation results.

Vegetation

Topography, soil and climate, factors of runoff and erosion discussed thus far, must for the purpose of this report be considered more or less static. In contrast, however, the vegetation is a rapidly changing element and around this factor the ultimate erosion on the Sundance fire hangs. The entire question of erosion control, disregarding for the moment the values at stake, resolves itself into whether or not the vegetation destroyed by fire will become reestablished in a reasonable length of time. Naturally this is somewhat a matter of conjecture but indications eight weeks after the area burned over, observations on old fires and experience of men long acquainted in the locality furnish a valuable basis for discussion.

Before proceeding further, however, at least 40 percent of the

Table 1: Mean Monthly Precipitation at Sundance, Wyoming
(U. S. Weather Bureau Summary - 1930)

<u>Month</u>	<u>Precipitation Inches</u>
January	1.15
February	.98
March	1.66
April	1.71
May	2.77
June	3.17
July	2.33
August	1.56
September	1.56
October	1.64
November	1.08
December	<u>1.15</u>
Total	20.76



Fig. 6. Cele Canyon. Black spots indicate crown fire areas. Remainder burned by fire of varying intensities from none to severe surface fire. In many places ample vegetation to afford soil protection still remains.

fire area can be eliminated as affording a problem from the standpoint of rehabilitation of the plant cover. Such a statement is feasible because on this portion of the fire the burn was not severe enough to destroy all of the plant cover and enough remains to prevent any large scale erosion. Survival of the vegetation, with the exception of Trent, South Ogden and Lower Ogden Canyons, is particularly pronounced along the stream bottoms which is fortunate because these areas carry the concentrated runoff and are particularly critical.

The remaining 60 percent, more or less, of the fire area does offer a problem of restoration of a mantle of organic matter over the soil and in the opinion of the investigators the following observations point toward the ultimate solution. First, sprouting shrubs are fairly abundant on the portions of area suffering the most severe burn. Eight weeks after the fire new oak and aspen sprouts were in evidence over a considerable area in Ogden Canyon and tributaries. Second, weeds such as dogbane and dandelion have made considerable growth within eight weeks after the fire. Third, where the fire was of such intensity as to consume all of the surface vegetation and to kill the forest overstory without consuming the foliage, there has been a heavy needle cast and where the timber stand was moderately dense the ground is now clothed with a mat of dead pine needles. Fourth, fire areas two and five years old elsewhere in the Black Hills National Forest were examined and on both areas the stand of grass, weeds and shrubs was sufficient to afford ample protection to the soil. It is anticipated that similar recovery will take place on the Sundance fire as no striking differences in soil, climate or intensity of the burn stand out between the new and the old burns. To summarize briefly it is anticipated that natural recovery of the lesser vegetation will be rapid and fairly complete. Of course, some erosion and flood waters can be expected while the process is under way but after seeing old fire areas it is difficult to believe that the loss of lesser vegetation will be felt over a period exceeding two years.

It is recommended, however, that in order to hasten recovery as much as possible, grazing be excluded from the area until such time as the local forest officers see fit to remove restrictions. It is recommended, also, in view of the attention that has been given this area, that commercial logging be excluded.

Values at Stake

A rather detailed discussion of the physical and biological characteristics of the Bearlodge fire area has been presented without



Fig. 7. Oak sprouts eight weeks after the fire.



Fig. 8. Needle cast 8 weeks after the fire. This is common on areas where the trees were killed but foliage not consumed. Stack of needles in foreground scraped from one square yard.



Fig. 9. Recovery on old burns. Upper view shows north slope on the five year old Rockford burn. The lower view shows south slope on two year old Bloody Gulch burn.

regard to the economic considerations involved. In order, however, to include all possibilities, assume for the moment that erosion on the fire area will be very serious, that mud-rock flows will issue from the canyons, and flood waters will be frequent and high. Obviously, these destructive forces cause or do no damage unless they destroy something of value and it is equally obvious that control of these destructive forces cannot be undertaken unless the values at stake begin to approach the cost involved. Consequently, it is only sound economics to balance value received against cost in any investigation such as reported herein.

Immediately below and adjacent to the fire area within the path of mud-flows which may issue from the burned canyons are not to exceed six farms. The best land on any one of these farms is assessed not to exceed \$20.00 per acre and there is not more than 100 acres of land that approaches this value. In Ogden Canyon, the most likely place for devastating erosion to occur, 15 acres valued at approximately \$300 (total value) are in danger of being ruined. Erosion control on the watershed at best would cost \$40 per acre and would need to cover some 1000 to 2000 acres making a total investment of \$60,000 to \$80,000 to protect \$300. Of course, other things such as roads, bridges and other improvements are at stake and possibly some roads will be covered with debris and bridges washed away. As it so happens, however, only a county road built at a cost not to exceed \$200 a mile lies in the path of possible mud flows and if this road together with bridges was completely ruined for its entire length along the fire not more than \$2500 would be lost.

Human lives will not be endangered as the farms near the burn are well protected from any real death-dealing blow. Highways or railroads are not endangered as none cross the zone of influence of the fire area. Large cities or towns will not be inundated by flood waters from the fire as the water would have an opportunity to spread over many thousands of acres before reaching Belle Fourche, the nearest city of any size.

In fact, after reviewing the situation rather carefully it would seem safe to say that more money has been spent already on inspections of possible erosion on the fire area than could ever be justified for erosion control measures from the standpoint of values at stake.

If the seriousness of the situation is viewed in terms of damage which may result from erosion and rapid runoff from the fire area to lands at some distance from the burn, say, Beulah 20 miles distant, or Belle Fourche some 50 miles distant, the possibilities of erosion control become even more unfeasible. Sweeping as this statement may seem

it becomes very obvious when it is considered that the fire covered only about 15 percent of the Sundance and Rocky Ford Creeks drainage above Beulah and a very insignificant area above Belle Fourche; while on the remaining unburned lands largely outside the national forest boundary, range depletion has progressed to a point where erosion is accelerated and rapid run-off inevitable. To do erosion control on the fire area would merely be a "drop in the bucket" and have little value from the long time standpoint unless the unburned but overgrazed lands were treated also. Treatment of the grazing lands is too large and expensive a task to undertake. Therefore, it would hardly be practical to assume that erosion control on the fire area would be a panacea for all evils.

Effects of the July 11 Storm

Erosion on the fire area up to September 1, 1936, occurred almost entirely during the storm of July 11 when 1.02 inches of rain fell in Sundance within 20 to 30 minutes. As to be expected, this storm produced high water from all burned-over canyons and considerable debris, mostly ash, was deposited on the flood plains at the mouths of the canyons. As far as the investigators could determine, the only soil and rocks deposited by the flood waters were those in Ogden Canyon and in small unnamed draws south of Ogden Canyon. In Ogden Canyon a portion of the cultivated land on one farm was covered with flood waters, ash that caused no damage was deposited over about 10 acres and soil and debris requiring some clearing but causing no permanent damage were scattered over 3 to 5 acres. No bridges were washed out and no roads were blocked by detritus.

In examining the area it was necessary to use considerable care in distinguishing between out-washes occurring prior to the fire and those which could be attributed to the rapid run-off following denudation. These old out-washes are fairly common and the fact that they exist and were considered in the field inspection is mentioned here merely to point out the necessity for caution in drawing conclusions from superficial examination.

It would seem folly to endeavor to predict the erosion that may result in the future on the fire area but with a reasonably normal succession of events it appears very unlikely that the cutting and washing caused by the July 11 storm will be greatly exceeded. At one point along the county road below the fire area, a short distance out of Sundance, flooding and mud-rock deposition will probably occur. And the farm in Ogden Canyon may have an acre or so more land covered by debris. The log bridge on Ogden Creek may wash out but in all not to



Fig. 10. Most serious out-wash occurring since the fire on agricultural land. About three acres in this field are strewn with rock a foot in diameter and smaller. This picture taken looking toward the hills from the single Ogden haystack.



Fig. 11. Debris washed from a small draw outside the forest boundary. Road in foreground may be flooded and covered with mud and rocks before vegetation is reestablished. Note dark streak in grass below the road, which is the high water mark formed by ashes carried in the run-off from the July 11 storm.



Fig. 12. High water as shown by man on one side and hat on the other in Ogden Creek. Note this is more than a foot higher than what appears to be the old high water mark. No damage was done by these flood waters except deposit mud, rock and ashes on a portion of 10 acres of farm land above this point.



Fig. 13. Trail along the toe of a 40 percent slope yet it shows no cutting or filling as a result of the storm of July 11.



Fig. 14. Old skid trail. Little cutting took place in this trail as evidenced by grass in the bottom. Rocky nature of the soil certainly lowers the erosion potential.



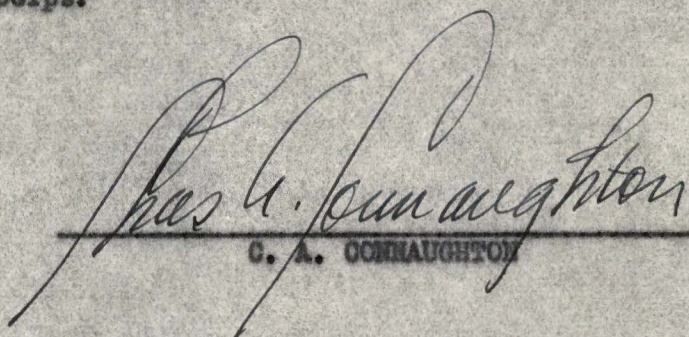
Fig. 15. Old out-washes such as this one with a 12 inch D.B.H. ponderosa pine growing on it should not be confused with out-washes from the July 11 storm.

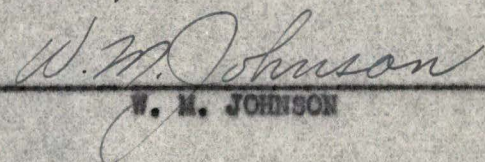
exceed \$2000 damages at the most can be expected.

Recommendations

After carefully examining the fire area with view toward erosion control, one major recommendation seems obvious-- let Nature heal her own wounds without the aid of engineering structures. Protect the burn from grazing and fire and it may also be wise not to attempt to salvage any of the dead timber for commercial purposes.

Inspect the area frequently during the next year or two to determine the rate at which the lesser vegetation is being restored. If by a combination of fire and drought the grass sod has been killed some artificial reseeding may be necessary using seed collected locally by the Civilian Conservation Corps.


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